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PHYSICS AND MATHEMATICS

No. 79

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10 August 1982

**USSR REPORT  
PHYSICS AND MATHEMATICS**

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## CRYSTALS AND SEMICONDUCTORS

UDC 539.2

### CRITERION OF JUMPCWISE LOW-TEMPERATURE PLASTIC DEFORMATION DURING VIBRATIONS

Kiev FIZIKA NIZKIKH TEMPERATUR in Russian Vol 7, No 11, Nov 81  
(manuscript received 8 Jun 81) pp 1475-1478

ZHITOMIRSKIY, I. S. and NECHIPORENKO, I. N., Physico-Technical Institute of Low Temperatures, UkrSSR Academy of Sciences, Khar'kov

[Abstract] A criterion is established for jumpwise plastic deformation during vibrations at low temperatures. It is based on the uniaxial state of stress and strain of single crystals or polycrystals with plastic flow beyond the yield point and attendant energy dissipation. Combining the equations of heat balance and mechanical vibrations yields the condition of self-excitation as the criterion of jumpwise deformation. Further analysis reveals that fluctuations of the total strain with a period not shorter than the duration of a jump of plastic strain raise the temperature at which such jumps begin to occur. The authors thank A. I. Landau for discussing the results several times. References 9: 8 Russian, 1 Western.

[167-2415]

### PHOTOLUMINESCENCE FROM EPITAXIAL GaAs LAYERS AFTER LASER TREATMENT

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 7, 12 Apr 82 (manuscript received 8 Feb 82) pp 436-439

KALANDARISHVILI, K. G., KOVAL'CHUK, Yu. V. and PORTNOY, Ye. L., Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] A study was made of the effect of laser treatment on the photoluminescence spectrum of epitaxial GaAs layers produced by the MOS-hydride process or by the molecular-beam process. Specimens of both kinds were annealed with pulses of 3 ns duration from a YAG:Nd<sup>3+</sup> laser ( $\lambda = 1.06 \mu\text{m}$ ) operating in the Q-switched mode. Photoluminescence was then excited at 77 K with an LG-106M-1 argon laser (principal lines 488.0 and 514.5 nm). The

spectrum most appreciably affected was that of GaAs layers produced by MOS-hydride epitaxy with strong doping, the intensity of the edge band decreasing by two orders of magnitude and the intensity of the 1.29 eV impurity band increasing by a factor of 3, while the spectrum of those with weak doping changed insignificantly after treatment with  $0.1 \text{ J/cm}^2$  laser pulses. The spectrum of GaAs layers produced by molecular-beam epitaxy was affected differently, the intensity of the impurity band increasing appreciably but the intensity of the edge band changing hardly at all after treatment with  $0.4 \text{ J/cm}^2$  laser pulses. The results indicate that it is feasible to alter the luminescence characteristics of crystalline semiconductor layers by short laser pulse action. The authors thank V. B. Smirnitskiy, V. I. Smil'gyavichus, B. S. Yavich and P. S. Kop'yev for assisting in this study. Figures 3, references 4: 1 Russian, 3 Western.

[172-2415]

UDC 535.376.2

PHOTOVOLTAIC CELLS BASED ON  $\text{Cu}_2\text{S}-\text{Zn}_x\text{Cd}_{1-x}\text{S}$  HETEROJUNCTIONS MADE BY TRANSFER IN HYDROGEN STREAM

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 3, Mar 82  
(manuscript received 20 May 81) pp 519-520

RAZYKOV, T. M., RAZYKOVA, M. A. and AKHMATSHAYKHOV, M., Physicotechnical Institute imeni S. V. Starodubtsev, UzSSR Academy of Sciences, Tashkent

[Abstract] The authors demonstrate the feasibility of making thin-film photovoltaic cells based on solid solutions of  $A^2B^6$  semiconductor compounds, and in particular on the basis of  $\text{Cu}_2\text{S}-\text{Zn}_x\text{Cd}_{1-x}\text{S}$  heterojunctions by transfer in a stream of hydrogen. The initial materials were CdS and ZnS powder vaporized into the gas stream from discrete sources, forming a layer of  $\text{Zn}_x\text{Cd}_{1-x}\text{S}$  solid solution on a molybdenum backing. The  $\text{Cu}_2\text{S}$  barrier layer was produced by chemical treatment in an aqueous solution and by reacting cuprous chloride from the solid phase with the  $\text{Zn}_x\text{Cd}_{1-x}\text{S}$ . Films of  $\text{Zn}_x\text{Cd}_{1-x}\text{S}$  were produced with different compositions in the range  $0 \leq x \leq 1$  doped with indium. X-ray spectral analysis showed a polycrystalline structure of the Würzite type with c-axis perpendicular to the backing. Studies of the optical width of the forbidden band of the films as a function of composition showed that as  $x$  increases the spectral sensitivity of the heterojunction is shifted toward the short-wave region ( $0.3 < \lambda < 0.5 \mu\text{m}$ ), whereas the photoresponse of the long-wave region ( $\lambda > 0.9 \mu\text{m}$ ) remains unchanged. This shows the formation of chalcocite for all heterojunctions regardless of composition of the base. The specimens typically had high spectral sensitivity over the entire band. The form of spectral

dependence of photocurrent was similar to that of Cu<sub>2</sub>S-CdS heterojunctions. Cells with optimum base composition in direct sunlight generated emf of 0.55-0.65 V at current density of 14-16 mA/cm<sup>2</sup> with efficiency up to 8%. Figures 3, references 12: 6 Russian, 3 Western.

[160-6610]

UDC 621.382.8:539-216.2

#### CHANGE IN OPTICAL PROPERTIES OF THIN FILMS RESULTING FROM ION IMPLANTATION

Moscow POVERKHNOST': FIZIKA, KHIMIYA, MEKHANIKA in Russian No 4, Apr 82  
(manuscript received 19 Oct 81) pp 87-89

KAMARDIN, A. I. and RADZHABOV, T. D.

[Abstract] An investigation is made of the way that bombardment with different kinds of ions affects the physicomechanical and optical properties of films used as masking coatings in making semiconductor devices. The materials studied include chromium, molybdenum and ferric oxide sputtered films, as well as organic films centrifugally applied to K-8 glass backings. Thickness of the metallic and oxide films did not exceed 0.3 μm, and the organic films ranged in thickness from 0.1 to 2.5 μm. Thickness was measured by the MII-4 interferometer, coefficients of transmission in the visible part of the spectrum were checked on the NU-2E microscope and SF-10 spectrophotometer. Mechanical stability of the films was determined from the critical breaking load by a corundum needle. An ion-beam doping facility was used for ion bombardment. Plots are given for the optical density of films as a function of the dose of irradiation, and as a function of the energy of irradiation with argon ions in a dose of 10<sup>16</sup> ions/cm<sup>2</sup>. A table summarizes the optical and mechanical properties of films exposed to various ions. It is shown that ion bombardment of thin polymer films changes their structure, giving rise to crosslinking that influences the mechanical, chemical and optical properties of the films, and determines the behavior of films of various composition and thickness when exposed to ion bombardment. The proposed technique can be used to modify the parameters of masking layers in predetermined ways for production of semiconductor devices. Figures 2, table 1, references 4: 3 Russian, 1 Western.

[173-6610]

FLUID DYNAMICS

UDC 517.9:532.5

DIFFRACTION OF KLEIN-GORDON INTERNAL WAVES BY HALF-PLANE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 264, No 1, May 82  
(manuscript received 25 Nov 81) pp 73-75

GABOV, S. A., Moscow State University imeni M. V. Lomonosov

[Abstract] Small vibrations of an incompressible fluid with density varying exponentially in the direction normal to the direction of plane flow is described by an equation which, upon integration, can be reduced to a Klein-Gordon wave equation. The problem of diffraction of such a wave by a solid wall at infinity is analyzed, asymptotic solutions being found for both "bright" and "shadow" subregions of the wave field. An examination of all diffraction terms reveals an intricate pattern, including an overdamped radial component, attributable to scattering of internal waves. The author thanks A. G. Sveshnikov for supporting this study. Article presented by Academician A. N. Tikhonov 4 November 1981. References 2 Russian.

[170-2415]

UDC 533.6.011

REGULAR REFLECTION OF SHOCK WAVE BY RIGID WALL

Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 46, No 2, Mar-Apr 82  
(manuscript received 3 Jun 81) pp 225-234

TESHUKOV, V. M., Novosibirsk

[Abstract] Motion of a nonviscous thermally nonconducting gas is considered and, on the basis of a piecewise-analytical solution to the equations of gas dynamics, the reflection of a shock wave by a stationary rigid wall is analyzed. Relations in the shock wave, with a front of arbitrary form, are established for the case of geometrically regular reflection realizable during the first stage. After transformation of the equations and boundary conditions

to new coordinates, in accordance with the applicable Cauchy problem, their solution is sought in the class of formal power series. The existence of an analytical solution in the supersonic case is demonstrated on the basis of convergence of these series, by constructing the majorants of the solution and solving the auxiliary majorant problem. A one-sheeted reflection is demonstrated on the basis of relations in the corresponding Jacobian and by application of the implicit-function theorem. The solutions obtained here describe the complete flow of gas behind the reflected wave, including the flow in its trail. The author thanks L. V. Ovsyannikov for his interest.

References 5 Russian.

[179-2415]

UDC 536.255

#### STEADY-STATE SHAPE OF BODIES DISINTEGRATING DUE TO RADIATIVE HEATING IN HYPERSONIC STREAM

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 20, No 2, Mar-Apr 82  
(manuscript received 16 Dec 80) pp 283-287

BRYKIN, M. V., Institute of High Temperature, USSR Academy of Sciences

[Abstract] The steady-state shape of the frontal surface of bodies disintegrating due to radiative heating in a hypersonic stream is defined as the shape which, in a system of coordinates fixed with respect to the body, does not change during the ablation process. Various determinations of this shape have been made for blunt axisymmetric bodies by numerical methods, inasmuch as adequate analytical expressions for the radiation flux distribution over the body surface are not available. The main problem is to establish satisfactory empirical relations. It has been assumed that the disintegration rate is proportional to the incident thermal radiation flux, with the necessary condition for steadiness of shape thus being that  $q_w/q_x^0 = \cos\theta(x)$  ( $q_w^0$  - radiation flux at stagnation point,  $q_w$  = radiation flux at any surface point,  $\theta(x)$ -angle between direction of oncoming hypersonic stream and normal to body surface at point  $x$ ,  $x$ - longitudinal coordinate on surface with origin at stagnation point), and that ablation does not significantly distort the original radiation flux distribution. Data have been obtained by this and other authors for spheres and blunt cones in an adiabatic shock layer of equilibrium air at stream velocities  $N_{M,\infty} = 20$  and 60. The results are difficult to compare and correlate, especially since convective heating also occurs and must be taken into account. The author thanks L. M. Biberman and S. Ya. Bronin for continuous interest in this study and helpful discussions. Figures 4, table 1, references 14: 10 Russian, 4 Western.

[180-2415]

## LASERS AND MASERS

### COAXIAL PUMPING OF GAS LASER WITH HIGH-POWER FOCUSED PROTON BEAM

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 7,  
12 Apr 82 (manuscript received 11 Jan 82) pp 385-388

SULAKSHIN, S. S. and TOLOPA, A. M., Scientific Research Institute of Nuclear Physics, Tomsk Polytechnic Institute

[Abstract] Coaxial pumping of Ar-N<sub>2</sub> and XeCl (He-Xe-CCl<sub>4</sub>) gas lasers with a linearly focused proton beam was tried experimentally for the first time, using a magnetically insulated diode. The latter consisted of a cylindrical "squirrel cage" cathode 13 mm in diameter coaxially inside a cylindrical anode with a radial gap of 1-1.5 cm between them. The insulating azimuthal magnetic field was produced by a current flowing from an external battery along the cathode. A perforated polyethylene insert lining the inside surface of the anode served as source of a proton emitting plasma. The diode was placed on a TONUS high-current particle accelerator operating in the reverse mode. Emission was recorded in both mixtures: in Ar:N<sub>2</sub>=80:20 under p = 1.5 atm at  $\lambda$  = 337.1-380.5 nm (energy 0.45 J, efficiency 0.8%) and in He:Xe:CCl<sub>4</sub> = 3000:400:4 under p = 2 atm at  $\lambda$  = 308 nm (energy 1 J, efficiency 0.37%). The authors thank A. N. Didenko and V. M. Bystritskiy for formulating the problem and supporting the study, also V. G. Tolmachev for participating in the experiment. Figures 2, references 7: 5 Russian, 2 Western.

[172-2415]

UDC 621.373.5

### DYE LASER WITH OPTICAL PUMPING AT PULSE REPETITION RATES UP TO 50 HZ

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 36, No 4, Apr 82  
(manuscript received 13 May 81) pp 674-676

ALEKSEYEV, V. A., MIKHALINA, T. I., NIKIFOROV, V. G. and SOPIN, A. I.

[Abstract] The emission characteristics of a dye laser with optical pumping were studied, for the purpose of finding ways to increase its average power and decrease its divergence. Three different configurations of lamp and active

medium inside the reflector shell were tried: 1) lamp and one dye cell ( $0.85 \text{ cm}^3$ ) cooled simultaneously, 2) lamp and one dye cell ( $0.85 \text{ cm}^3$ ) with only the lamp cooled, 3) lamp and two dye cells (total volume  $0.85$  or  $1.7 \text{ cm}^3$ ) with only the lamp cooled. For cooling the lamp only the latter was placed inside a quartz tube. Optical resonators were formed by plane dielectric mirrors optimally matching the dyestuff. Curves depicting the dependence of emission energy on pumping energy up to 50 J and the dependence of average emission power on pulse repetition rate up to 50 Hz, on the basis of measurements, indicate that the second configuration is most efficient. Use of two dye cells with independent resonators makes possible emission at two wavelengths simultaneously. In the experiment with separate ethanol solutions of Rhodamine-6G and 9-diethyl-aminobenzophenoxy-azinon-5 in optimum concentrations yielded laser emission of 1.5 W at the 595 nm wavelength and 1 W at the 665 nm wavelength with a pulse repetition rate of 50 Hz. Figures 2, reference 1 Russian.

[171-2415]

UDC 535.33:628.328.325

#### SPECTRAL ENERGY CHARACTERISTICS OF FREE EMISSION IN NEODYMIUM GLASSES AT ELEVATED TEMPERATURES

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 36, No 4, Apr 82  
(manuscript received 25 May 81) pp 599-603

DANIL'CHUK, N. V. and SHAPOVALOV, V. N.

[Abstract] A systematic study was made of free emission in neodymium glasses (phosphate grades GLS21-24 and KGSS-1621-1, silicate grades GLS1-4, germanate grade KGSS-101, lead-phosphate grades KGSS-F628 and KGSS-M628-3, quartz glass), namely the temperature dependence of its energy and spectrum over the 300-600 K range and in some cases up to 750 K. Tests were performed in the monopulse mode, using active media 10 mm in diameter and 130 mm long with multilayer dielectric coatings placed inside an illuminator-furnace. The data are interpreted on the basis of equations for a four-level system with population inversion. The results indicate a strong dependence of the spectrum position and width on the excess above threshold and on the temperature of the active medium. Selective absorption from thermally populated  $4I_{11/2}$  Stark components reduces both output energy and efficiency of emission while shifting and narrowing the spectrum. It thus appears feasible to control the emission spectrum by varying the temperature of the active medium. The author thanks M. N. Tolstoy for helpful discussion of the results. Figures 3, references 8 Russian.

[171-2415]

CUTOFF REPETITION RATE OF LASER ON PHOSPHATE-NEODYMIUM GLASS

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 36, No 4, Apr 82  
(manuscript received 19 May 81) pp 568-574

ALEKSEYEVA, V. A. and KHANKOV, S. I.

[Abstract] The cutoff repetition rate of a neodymium laser is determined on the basis of its dependence on such limiting factors as strength of active medium, thermal deformation of resonator, temperature rise above threshold, cooling intensity and thermal reduction of gain. General relations are derived for the stationary temperature field of a cylindrical active medium with uniform internal heat generation and steady heat dissipation through the lateral surface. The cutoff repetition rate as well as the emission cutoff temperature have been calculated for a laser on grade GLS 22 phosphate-neodymium glass. The necessary coefficients have been determined on the basis of experimental data for this glass as well as other grades (GLS 23, GLS 24, also KGSS 1111 and KGSS 083) using mirrors with various radii from 0.20 to 0.79 cm, these data fitting the theoretical relations within 10%. The results are useful for design of laser cooling as a function of operating parameters. Figures 2, references 12 Russian.

[171-2415]

NONLINEAR OPTICAL EFFECTS IN PLASMA OF LASER SPARK IN FIELD OF NANOSECOND PULSES FROM Nd:YAG LASER

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 8, 26 Apr 82 (manuscript received 25 Dec 81) pp 497-502

BRODNIKOVSKIY, A. M., GLAIKOV, S. M., ZAIKOV, V. N., KARIMOV, M. G. and KOROTEYEV, N. I., Moscow State University imeni M. V. Lomonosov

[Abstract] Second-harmonic generation with efficient coherent "nonresonant" four-photon processes as well as efficient "nonresonant" generation of anti-Stokes signals were observed in the plasma of a laser spark in two series of experiments involving breakdown of gases (air, argon, carbon dioxide, sulfur hexafluoride) under atmospheric pressure by focused nanosecond pulses from a low-power (10 kW) Nd:YAG Q-switched laser. These nonlinear optical effects are attributed, respectively, to quadratic "Lorentz" nonlinearity of the electron component in the plasma, with spatially nonuniform distribution of free electrons in the spark, and to changes in the nonlinear optical characteristics of the gaseous medium upon appearance of the electron component after

breakdown. Optical breakdown was not found to significantly alter the form and the position of Raman scattering spectra of molecular gases involved in these experiments. The authors thank S. A. Akhmanov for support and stimulating discussions. Figures 2, references 15: 4 Russian, 11 Western.  
[178-2415]

#### SELF-EXCITED FLUCTUATIONS DURING INTERACTION OF LASER BEAM AND SOLID TARGET SURFACE IN GASEOUS ATMOSPHERE UNDER ELEVATED PRESSURE

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 8,  
26 Apr 82 (manuscript received 27 Oct 81) pp 481-485

UGLOV, A. A. and IGNAT'YEV, M. B.

[Abstract] The theoretically predicted self-oscillatory variation of the transmission coefficient in a laser plasma cloud near the surface of a solid target was confirmed in an experiment with a neodymium pulse laser (radiation flux density approximately  $3 \cdot 10^6$  W/cm<sup>2</sup>) and a copper target (approximately 0.5 mm thick with a beam hole approximately 100 μm in diameter) in an atmosphere of nitrogen (10-100 atm) and carbon dioxide (10-50 atm). Measurements by the method of longitudinal transillumination have established a relation between the fluctuation parameters of the transmission coefficient and the pulse form of the laser radiation. The results are interpreted qualitatively in terms of heating and evaporation with attendant erosion and shielding effects, the plasma providing negative feedback between laser beam and target surface. Quantitative estimates are made, disregarding the effect of capillary and gravitational forces at the beam hole. At a sufficiently high radiation flux density ( $5 \cdot 10^7$  W/cm<sup>2</sup>) the self-oscillatory variation of the transmission coefficient was found to cease, owing to breakdown of the gas, and the mode of its subsequent variation to depend on the evolution of the plasma cluster at the surface. Figure 1; references 10: 9 Russian, 1 Western.  
[178-2415]

POSSIBILITIES OF MORE EFFICIENT GENERATION OF ELECTRIC CURRENT BY LASER RADIATION

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 8, 26 Apr 82 (manuscript received 29 Jan 82) pp 472-478

ASKAR'YAN, G. A. and RAYEVSKIY, I. M., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] Conversion of laser radiation to electric current at a target has important applications in high-temperature physics research as well as in long-distance energy transmission. The efficiency of such conversion is still very low, of the order of  $10^{-2}\%$ , as compared with that of conversion of microwave energy (15%). Here the causes of this inefficiency are analyzed on the basis of an equivalent resistive-inductive circuit representing the target with hot plasma and the collector with a load. Both pulse and integral efficiency of energy conversion are calculated, taking into account the pulse shape of the emission emf and that of the generated current. In an experiment with a neodymium laser, a focusing lens, and a cylindrical copper target inside a hollow cylindrical copper collector pulses were produced with 150 MW power and 22 ns duration (referred to half-power level). It has been found feasible to increase the conversion efficiency by effectively decreasing both resistance and inductance of the equivalent circuit as well as the time constant of the emission emf, by tailoring pulses and eliminating feedback. This method should be equally applicable to radiation from a CO<sub>2</sub> laser. Figures 2, table 1, references 11: 5 Russian, 6 Western.

[178-2415]

HIGH-EFFICIENCY PICOSECOND PULSE LASER BASED ON CONCENTRATED NEODYMIUM-PHOSPHATE GLASS

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 8, 26 Apr 82 (manuscript received 23 Dec 81) pp 465-468

VISHCHAKAS, Yu., GUL'BINAS, V., KABELKA, V. and SYRUS, V., Institute of Physics, LiSSR Academy of Sciences, Vilnius

[Abstract] An experimental study was made on the feasibility of generating very short high-energy laser emission pulses with concentrated neodymium-phosphate glass as active medium. The equipment included a 1.8 m long resonator cavity between two wedge-shaped dielectric mirrors with reflection coefficients 99.9 and 50% respectively, a stabilizing 1:2 telescope inserted into this cavity, an IFP-800 flash lamp for pumping, a vessel through which a

solution of 3274 modulating dye in isobutyl alcohol was pumped from mode locking, a negative lens before the amplifier for better utilization of the active medium and prevention of large-scale self-focusing of the beam, and a positive lens behind the amplifier for compensating the beam divergence. With a pumping energy of 300 J, trains of laser pulses were generated with 20 mJ energy and picosecond duration at a 20 Hz repetition rate. Single pulses were extracted with 7 ps duration and average 1.0 mJ energy. The experiment also included statistical measurements and conversion of fundamental radiation ( $\lambda = 1.06 \mu\text{m}$ ) to second and third harmonics by means of KDP (potassium-deuterium phosphate) or LiIO<sub>3</sub> crystals. In the latter case effective stimulated Raman scattering was recorded with a total energy appreciably exceeding that of the second-harmonic emission. Figures 2, table 1, references 5: 4 Russian, 1 Western.  
[178-2415]

#### SIMPLE DYE LASER WITH DISTRIBUTED FEEDBACK AND EMISSION LINewidth OF 0.01 cm<sup>-1</sup>

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 8, 26 Apr 82 (manuscript received 14 Dec 81) pp 460-462

IL'ICHEV, N. N., MALYUTIN, A. A., PASHININ, P. P., RASPOROV, S. F. and SUKHODOL'SKIY, A. T., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] A simple optical system is proposed for lasers with distributed feedback and narrow-band single-mode emission. The dynamic amplitude-phase array is produced by interference of two beams, one of them formed by reflection from a plane mirror. In an experiment using Rhodamine-6G as the active medium, a high-concentration neodymium-phosphate (glass) laser as the master oscillator and an LiF crystal with F<sub>2</sub> centers as Q-switch, emission was obtained within a 0.01 cm<sup>-1</sup> narrow band. Placement of a positive lens at a distance of about one focal length from the mirror (50 cm) reduced the diffractive divergence to about 1 mrad and the emission threshold to 10 kW. In addition to its simplicity and that of the tuning mechanism, the main advantages of this system are unilateral emission without adjustment of the pumping beams and elimination of costly diffraction gratings. It could provide a useful tool for nonlinear spectroscopy requiring two laser beams with adjustable frequency separation. Figures 2, references 4 Russian.

[178-2415]

## COMPUTER-AIDED SYNTHESIS OF FOCUSING ELEMENTS FOR CO<sub>2</sub> LASER

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 8,  
26 Apr 82 (manuscript received 2 Feb 82) pp 449-451

GOLUB, M. A., DEGTYAREVA, V. P., KLIMOV, A. N., POPOV, V. V., PROKHOROV, A. M.,  
SISAKYAN, YE. V., SISAKYAN, I. N. and SOYFER, V. A., Institute of Physics  
imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] Computer-aided synthesis of holograms is useful for producing unconventional optical devices such as light beam focusing elements. Two kinds of "kinoforms" with smooth phase variation over each ring have been developed by these authors on this basis for a light beam at  $\lambda = 10.6 \mu\text{m}$  wavelength from a CO<sub>2</sub> laser. One of them with a focal length of 30 cm, an analog of a conventional spherical mirror, focuses the beam to a point. The other focuses the beam into a flat ring 25 cm in diameter at a distance of 30 cm. Figures 2, references 6: 4 Russian, 2 Western.

[178-2415]

## CO<sub>2</sub> PULSE LASER WAVEFRONT REVERSAL BY FOUR-WAVE INTERACTION IN SULFUR HEXAFLUORIDE

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 8,  
26 Apr 82 (manuscript received 27 Oct 81) pp 451-455

BASOV, N. G., KOVALEV, V. I., LESIV, A. R. and FAYZULLOV, F. S.

[Abstract] Feasibility of wavefront reversal of middle-infrared laser radiation by four-wave interaction was demonstrated quantitatively by photographic recording of the field distributions in both signal wave and reversed wave. In the experiment the beam from a CO<sub>2</sub> pulse laser on the P(22) line ( $\nu = 924.4 \text{ cm}^{-1}$ ) was split by a plane mirror into a signal wave and a reference wave. The latter was reflected by another plane mirror, the second reference wave being formed as a result. With the aid of two other plane mirrors, the signal wave was superposed on both reference waves inside a cell containing SF<sub>6</sub> under a pressure of about 150 mm Hg. The relation between accuracy of reversal and divergence of the signal wave indicates that, within experimental accuracy, 100% reversal is possible with an effective reflection coefficient up to 40% in terms of power and up to 10% in terms of energy. The authors thank B. Ya. Zel'dovich, M. A. Musayev and V. V. Shkunov for helpful discussions. Figures 3, table 1, references 6: 2 Russian, 4 Western.

[178-2415]

## NEW SCHEMES OF LASER TRANSITION EXCITATION

Leningrad ZHUPNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 3, Mar 82  
(manuscript received 26 May 81) pp 521-522

ANTIPENKO, B. M., MAK, A. A., SINITSYN, B. V., RABA, O. B. and UVAROVA, T. V.

[Abstract] Lasing is reported on new transitions of the  $\text{Er}^{3+}$  ion ( $^4\text{F}_{9/2} \rightarrow ^4\text{I}_{11/2}$ ,  $^4\text{F}_{9/2} \rightarrow ^4\text{I}_{13/2}$ ) in the  $\text{BaYb}_2\text{F}_8:\text{Er}^{3+}$  crystal (8% of  $\text{Yb}^{3+}$  sites) excited by cooperative processes of step-by-step sensitization. Pumping radiation was provided by a GLS-22 neodymium glass laser placed in a cylindrical illuminator made of diffusely scattering MS-14 glass. The optical cavity was formed by dielectric mirrors with selective reflectivity of 99.5, 88 and 99.5, 99.5% respectively on wavelengths of the transitions  $^4\text{F}_{9/2} \rightarrow ^4\text{I}_{11/2}$  and  $^4\text{F}_{9/2} \rightarrow ^4\text{I}_{13/2}$ . An analysis is made of the scheme of energy levels of the  $\text{Er}^{3+}$  and  $\text{Yb}^{3+}$  ions that take part in the lasing process. The results of this study demonstrate the realistic feasibility of efficient solid-state lasers with fundamentally new cooperative schemes of excitation of laser transitions. Figure 1, table 1, references 2: 1 Russian, 1 Western.  
[160-6610]

## MAGNETOHYDRODYNAMICS

UDC 533.9.01

### STRUCTURE OF TURN-OFF SHOCK WAVES IN PLASMA

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 3: FIZIKA, ASTRONOMIYA in Russian Vol 23, No 2, Mar-Apr 82 (manuscript received 10 Jun 80) pp 32-37

DANILOV, A. V., Chair of Quantum Theory

[Abstract] Propagation of a plane steady turn-off slow shock wave along the axis of a simple completely ionized plasma is considered, the equations describing it being the same as for a turn-on wave but the boundary conditions being different: existence of a transverse component of the magnetic field corresponds to minimum entropy and turn-off is possible at any inclination angle of the magnetic field. The structure of the wave front is determined on the basis of the equations of two-fluid hydrodynamics and heat transfer for ions and electrons, and their asymptotic analysis. One parameter in the solution is the degree of magnetization of both ions and electrons, the problem being solved for the two extreme cases of completely nonmagnetized and completely magnetized plasma. Supersonic and subsonic flow before the wave front are considered. The decrement of magnetization within the wave front, a characteristic feature of all slow waves, is found to be particularly appreciable in the case of a turn-off shock wave with subsonic flow both before and behind the front. The author thanks A. L. Velikovich and M. A. Liberman for formulating the problem and assisting in the work, also I. M. Lifshits for discussing the results. Figures 2, references 9: 6 Russian, 3 Western.

[168-2415]

NUMERICAL SIMULATION OF MHD-GENERATOR PERFORMANCE IN ELECTRIC POWER PLANT  
UNDER VARIABLE LOAD

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 20, No 2, Mar-Apr 82  
(manuscript received 20 Jan 80) pp 347-358

BITYURIN, V. A., IVANOV, P. P., KORYAGINA, G. M., LYUBIMOV, G. A.,  
MEDIN, S. A., MOROZOV, G. N. and PROKOP, A. S., Institute of High Temperatures,  
USSR Academy of Sciences

[Abstract] Performance of MHD generators in an electric power plant is analyzed by numerical simulation, the object being optimization of the performance under variable load and, particularly, ensuring maximum economy under partial loads. Regulating the flow rate of combustion products at the compressor, in combination with faster regulation of the electrical load at almost constant pressure in the combustion chamber, is found to be the best method of performance control and has been selected as basis for this study. Three types of MHD generator are considered with respectively optimum channel geometry: 1) Faraday generator with fully developable supersonic flow, 2) Faraday generator with limitation to subsonic flow, 3) frame generator with supersonic flow and with diagonal connection of electrodes limited to angles  $\alpha \geq 30^\circ$ . The performance of the MHD generator must match that of compressor, combustion chamber, and air preheater as well as that of steam generator and steam turbine. There is also a cooling system for both combustion chamber and MHD generator, which must be included in the analysis. For such a system, with nominal performance curves available, power-efficiency curves and other characteristics have been calculated corresponding to a 23% downward regulation of the flow rate of combustion products (190-140 kg/s in 20 kg/s steps). The specific fuel consumption (kg/kWh) increases by not more than 3-4%. Figures 9, tables 3, references 14: 13 Russian, 1 Western.

[180-2415]

INVESTIGATING BOUNDARY LAYERS IN MHD-GENERATOR PLASMA BY ELECTRIC PROBE

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 20, No 2, Mar-Apr 82  
(manuscript received 9 Jan 81) pp 229-235

BATENIN, V. M., VASIL'YEVA, I. A. and KOSOV, V. F., Institute of High-Temperature Physics, USSR Academy of Sciences

[Abstract] In order to fill a gap in experimental data, boundary layers in the plasma of U-25 and U-25B MHD generators at the Institute of High-Temperature Physics were measured with an electric current probe. Conditions in the two generators were tentatively estimated as follows: stream velocity 100 and 850 m/s, gas pressure 1 atm in both, plasma temperature 2300 and 2600 K, electron concentration  $10^{13}$  and  $10^{14} \text{ cm}^{-3}$ , channel wall temperature 500 and 700 K, radius of cylindrical probe 1 mm in U-25 generator channel with circular cross section 550 mm in diameter and 1.7 mm in U-25B generator channel with rectangular cross section of 340x1140 mm. A potassium salt was used as ionizable additive in the  $0.8\text{N}_2 + 0.2\text{H}_2\text{O}$  mixture. Both probes were made of stainless steel, including the electrodes, a double-cylindrical used for the U-25B generator. They were inserted into the plasma and moved around for a duration of 0.2-0.5 s, their position in space and time recorded during measurements along with their temperature. Processing of the data in accordance with the  $I = \text{const}(D, V)^{\frac{1}{2}} n_e$  relation ( $D$  - diffusion coefficient,  $V$  - stream velocity,  $n_e$  - electron concentration), assuming negligible recombination of charged particles at the probe surface, yielded the distribution of ion current over the boundary layer. In addition, temperature and velocity profiles were obtained fitting closely the  $\frac{1}{7}$ th-power law. The authors thank V. I. Stankevich and I. A. Kiselev for assisting with the experiments, also M. S. Benilov, V. A. Zhelin and V. D. Semenov for helpfully discussing the results.

Figures 5, tables 2, references 10: 7 Russian, 3 Western.

[180-2415]

MOLECULAR PHYSICS

HYPER-RAMAN SCATTERING OF LIGHT BY POLARITONS IN LIQUID CARBON TETRACHLORIDE

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian  
Vol 35, No 8, 20 Apr 82 (manuscript received 11 Feb 82) pp 312-314

DENISOV, V. N., MAVRIN, B. N., PODOBEDOV, V. B. and STERIN, Kh. Ye.,  
Institute of Spectroscopy, USSR Academy of Sciences

[Abstract] A study was made of hyper-Raman scattering by vibrational polaritons in a liquid. The necessary condition for dependence of the polariton frequency on the scattering angle, namely occurrence of transverse and longitudinal dipole vibrations with a wide transverse-longitudinal split, was found to exist in liquid  $\text{CCl}_4$ . The scattering spectrum and the polariton dispersion were measured at scattering angles from 0 to  $3^\circ$ , with the scattered light passing through annular diaphragms and collected at  $0.4^\circ$  angles equal to the divergence angle of the exciting radiation beam. The results agree closely with theoretical calculations and data on infrared spectra. They reveal a group velocity of polaritons much lower than the velocity of light and thus indicate that thermal motion of molecules in the liquid does not appreciably decrease the wave vector of polaritons during scattering of light. Figures 2, references 8: 6 Russian, 2 Western.  
[169-2415]

NUCLEAR PHYSICS

FOCUSING HIGH-CURRENT RELATIVISTIC ELECTRON BEAM WITH HIGH TIME RESOLUTION

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian  
Vol 35, No 8, 20 Apr 82 (manuscript received 13 Mar 82) pp 332-334

GORBULIN, Yu. M., ZLOTNIKOV, D. M., KALININ, Yu. G., SKORYUPIN, V. A. and  
SHASHKOV, A. Yu., Institute of Atomic Energy imeni I. V. Kurchatov

[Abstract] An experimental study was made of the dynamics of a focused high-current relativistic electron beam in the diode of an electron accelerator, with power fluxes of  $6 \cdot 10^3$  W/cm<sup>2</sup> density at current densities up to 80 MA/cm<sup>2</sup>. Measurements were made in a "Mirazh" test stand, using photographs of the focal spot taken in hard X-rays with time resolution and image converters with direct image transfer. Oscillograms reveal an initial sharp focusing for 50-60 ns, followed by defocusing due to increasing high-frequency oscillations of the unstable diode current with a period of a few nanoseconds. A focused electron beam changes its location on the anode with time and the foil segment it has heated up cools down in its wake. Therefore, the mean surface temperature of the whole focal spot is lower than it would be if the whole spot were heated throughout the entire duration of a pulse. This was pointed out by L. I. Rudakov. Figures 3, references 3: 1 Russian, 2 Western.  
[169-2415]

OPTICS AND SPECTROSCOPY

UDC 551.573

TRANSILLUMINATION OF HOT SOLID AEROSOL BY HIGH-INTENSITY LIGHT BEAM

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 36, No 4, Apr 82  
(manuscript received 22 May 81) pp 557-562

BUKATYY, V. I., TEL'NIKHIN, A. A. and SHAYDUK, A. M.

[Abstract] Transillumination of monodisperse solid aerosol is analyzed in the case where such an aerosol consists of burning particles such as soot, smoke, or metal particles. A light beam of high intensity and small divergence passes through the plane boundary of the half-space occupied by aerosol. Subsequent propagation of this beam is first considered assuming a steady beam and a stationary medium. The corresponding equations are then solved including both light beam dynamics and motion of the medium. The effects of wind are subsequently added, but the effects of diffusion and convection are found to be negligible. The problem reduces to an integral equation, with the burning time in the kernel, which can be solved with the aid of a Laplace transformation and the convolution theorem. Figures 2, references 6 Russian.  
[171-2415]

UDC 551.508.2

ABSORPTION COEFFICIENT OF VARNISH-PAINT COATINGS ON THERMAL-TYPE RADIATION RECEIVERS

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 20, No 2, Mar-Apr 82  
(manuscript received 19 Jan 81) pp 394-396

KMITO, A. A., SEREDENKO, M. M., PARFINSKIY, V. A., RUSAKOV, V. V., LIBERMAN, A. A. and KARPETS, A. P., Main Geophysical Observatory imeni A. I. Voyeykov, Leningrad

[Abstract] Maximum reproducibility of radiation measurement units is achievable with absolute receivers, not absolute radiators, according to the

relation  $E = \frac{i^2 r}{a F} AB$  ( $E$ - energy of incident solar radiation,  $i^2 r$ - equivalent electric power,  $a$ - integral absorption coefficient,  $F$ - receiver surface area). The correction factors  $A$  and  $B$  account respectively for varying thermal resistance of the receiver coating and varying heat transfer from receiver to ambient medium. The contribution of both variations to the measurement error can be greatly reduced by use of thermal-type receivers with cooling. The measurement error is then determined by the error in the absorption coefficient. Systematic periodic studies have been undertaken to determine the absorption characteristics of black varnish-paint coatings and, subsequently, ensure stability of their optical properties. Available data on the reflection coefficient of AK-243 paint, Parsons varnish and ZM varnish indicate that its magnitude at various wavelengths does not depend on the coating process but does appreciably depend on the coating thickness. This dependence is an exponential one, according to the Gurevich-Kubelka-Munk theory. For further study, water-soluble coatings were produced by the electrodeposition process, rather than by spray or with brush, to ensure uniform and reproducible thicknesses. On the basis of commercially available film forming pigments and fillers, compounds were formulated with specular reflectivity and minimum spectral selectivity. Four specimens were thus produced with an absorption coefficient  $a = 0.99953-0.99991$ , based on averages of three series of five readings for each, over the  $\lambda = 0.5-10.6 \mu\text{m}$  range of the spectrum. This corresponds to a selectivity not exceeding 0.05%. The measurement error did not exceed  $\pm 0.00003$  at each wavelength (0.5, 0.63, 1.15, 10.6  $\mu\text{m}$ ). Figures 2, table 1, references 5 Russian.

[180-2415]

UDC 535.36

#### CALCULATING ANGULAR AND SPECTRAL SELECTIVITIES OF HYPERSONIC REFLECTION HOLOGRAM

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 3, Mar 82  
(manuscript received 3 Aug 81) pp 504-510

VASIL'YEV, M. V. and SIDOROVICH, V. G.

[Abstract] Electrostrictive interaction between matter and the interference pattern produced by radiation that excites stimulated Mandelstam-Brillouin scattering (SMBs) and by radiation scattered in matter sets up a hypersonic reflection hologram. In this paper, the theoretical analysis is made of the angular and spectral selectivities of the hypersonic gratings that form the SMBs mirror in a wavefront reversal configuration. The BESM-6 computer is used with a program written in GDR-Algol to calculate curves of angular selectivity of the hypersonic hologram for different increments in gain of the

Stokes wave in the field of the stimulating radiation. Comparison of the theoretical curves with experimental plots of angular selectivity gives the increment in gain of the Stokes wave in the investigated material. It is shown that a double increment in the Stokes wave with reversed wave front is due to pairwise coherent summation of contributions that are made by components of the SMBS mirror of hypersonic gratings to each planar component of the Stokes wave. This paper was read in June 1981 at a seminar on three-dimensional and dynamic holography organized by the Scientific and Technical Society imeni A. S. Popov in Kiev. Figures 5, references 11: 8 Russian, 3 Western.  
[160-6610]

UDC 538.3

#### STIMULATED MANY-PHOTON EFFECTS ON DIFFRACTION GRATING

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 3, Mar 82  
(manuscript received 11 May 81) pp 554-556

OGANESYAN, S. G. and YENGIBARYAN, V. A., Yerevan State University, Scientific Research Institute of Physics of Condensed Media

[Abstract] An examination is made of stimulated effects that arise when a particle passes over a diffraction grating. The depth of modulation of the electron beam and broadening of its energy spectrum are proportional to the number of lines, which may be of the order of  $10^5$  in good gratings. It is assumed that a charged particle passes at a given distance above a diffraction grating with given period and gap width. A monochromatic electromagnetic wave linearly polarized along the axis parallel to the lines of the grating is normally incident on the lower surface of the grating. A theoretical analysis of the problem is given in the classical and quantum formulations. It is shown that the only electron taking part in stimulated processes are those at a distance of  $z_0 \sim \lambda(E/mc^2)$  from the grating surface. For non-relativistic energies, the total number of interacting particles can be increased by focusing the beam above the grating surface. For relativistic particles, if  $\lambda = 1 \mu\text{m}$ ,  $E = 500 \text{ MeV}$ , then  $z_0 \approx 1 \text{ mm}$ . Estimates of the power of electromagnetic radiation needed for increasing electron energy by 10% give  $2.68 \text{ kW/cm}^2$  for nonrelativistic particles ( $\beta = 0.1$ ),  $120 \text{ MW/cm}^2$  for energies  $E = mc^2$ , and  $67 \cdot 10^{13} \text{ W/cm}^2$  for relativistic particles  $E = 500 \text{ MeV}$ .

References: 4 Russian.

[160-6610]

## USING PULSED RUBY LASER FOR HOLOGRAPHIC INTERFEROMETRY OF ROTATING OBJECTS

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 3, Mar 82  
(manuscript received 13 Jul 81) pp 577-578

MOROZOV, N. V. and OSTROVSKIY, Yu. I., Physicotechnical Institute imeni  
A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] In a previous paper [N. V. Morozov, Kh. P. Alum, Yu. N. Ostrovskiy, ZHURNAL TEKHNICHESKOY FIZIKI, Vol 51, 1981, p 355], a method of holographic interferometry was considered in which Lippmann holograms of a rotating object were made with the recording medium secured to the axis of rotation. Since the object and photographic plate make hundreds of revolutions during exposure, severe requirements are imposed on alignment of the optical system and permissible wobble of the axis of rotation. The maximum permissible angle of deviation of the axis of rotation from the normal to the wave front of the illuminating wave is given by  $a_{cr} = \lambda/4d \tan \beta$ , where  $\lambda$  is wavelength,  $d$  is distance between the object and photographic plate, and  $\beta$  is the angle between the normal to the plate and the direction of light scattered by the surface of the object. These requirements can be appreciably reduced if we limit the angle  $\Delta\phi$  through which the object and plate turn during exposure. In this paper, an analysis is made of the change in path difference between references and object beams in the space of registration as the plate and object turn about an axis of rotation in the case of illumination by a parallel beam. The result shows that  $a_{cr} = \text{arc sin}(\lambda/4d \tan \beta \sin(\Delta\phi/2))$ . Experiments were done in which the cw laser was replaced by a pulsed laser to limit the angle of turn during recording of the hologram. Since the duration of the illumination pulse was a few periods of oscillations of the object, the result is time-average interferometry (Powell-Stetson method). The proposed technique relaxes requirements for wobbling and alignment by a factor of about 40 as compared with cw lighting. Figures 3, reference: 1 Russian.  
[160-6610]

SELECTING LASER EMISSION WAVELENGTHS TO GET HOLOGRAPHIC COLOR IMAGES

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian  
Vol 25, No 3, Mar 82 (manuscript received 28 Oct 80) pp 79-82

BUYMISTRYUK, G. Ya. and DMITRIYEV, A. Ya., Novosibirsk Electrical Engineering  
Institute of Communications

[Abstract] The author discusses the problem of selecting laser wavelengths to optimize image color quality when using three monochromatic light sources in color holography. The analysis is based on consideration of some specific aspects of color transmission of lighting sources and human color vision, and specifically the peculiarities of metarism. It is found that color stimuli that are metameristic under conditions of direct observation have different intensities (intersections) in narrow spectral zones near wavelengths of 450, 540 and 610 nm. It is concluded that metameristic identity of the colors of image and object in color holography can be achieved by using lasers that emit on these wavelengths. It is demonstrated that the proposed wavelengths represent an optimum compromise among the colorimetric, holographic and energy parameters in three-beam holography. Figures 2, table 1, references 7:  
4 Russian, 3 Western.

[164-6610]

CHOOSING OPTIMUM RELATION AMONG MAJOR PARAMETERS OF OBSERVATIONAL DEVICE WITH IMAGE CONVERTER TUBE

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian  
Vol 25, No 3, Mar 82 (manuscript received 1 Sep 81) pp 83-88

AVDEYEV, S. P., Leningrad Institute of Precision Mechanics and Optics

[Abstract] An analysis is made of the problem of optimizing the match of parameters of all components of an observational device with image converter tube with required linear resolution with respect to the field and required threshold contrast of the image on the photocathode in a predetermined energy situation under given conditions of observation: given characteristics of the separating media, recording device and objective lens, and conditions of registration of the image from the screen of the image converter tube, e.g. the level of screen lighting by external sources and the rate of image displacement. An analytical-graphic technique is proposed for matching the angle of view, sensitivity and resolution of such a device, and analytical expressions are given for evaluating these parameters under given conditions of observation. Figures 3, reference 1 Russian.

[164-6610]

## PLASMA PHYSICS

### PROPAGATION OF SHOCK WAVES THROUGH PLASMA OF GLOW DISCHARGE

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 7,  
12 Apr 82 (manuscript received 3 Feb 82) pp 439-443

KLIMOV, A. I., KOBLOV, A. N., MISHIN, G. I., SEROV, Yu. L. and YAVOR, I.P.,  
Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences,  
Leningrad

[Abstract] An experimental study of shock waves in the plasma of a glow discharge (degree of air ionization  $N_e/N_a \approx 10^{-6}-10^{-5}$ , electron temperature  $T_e \approx 0.5-2$  eV, pressure  $p_a = 30$  torr, temperature of neutral component  $T_a \leq 1000$  K) has revealed an anomalous increase of their velocity from 500-800 m/s in air to 1200-1300 m/s in the plasma and an appreciable flattening of the wave front from a rise time of 2  $\mu$ s in air to a rise time of 8-10  $\mu$ s in the plasma, at the maximum current density of 30 mA/cm<sup>2</sup>. These results indicate that a plasma is a strongly dispersing medium for gas dynamic perturbations. According to thermodynamic analysis, such a change cannot be attributed to heating of the gas in a nonuniform temperature field. It is more likely caused by relaxation with attendant release of energy in the vibrational degrees of freedom. The characteristics of shock waves in a plasma are determined by generation of ion-acoustic waves, a higher ionization of excited atoms and molecules, and appearance of an electric double layer at the front of a shock wave. The velocity of shock waves in a plasma depends neither on the direction of the electric field nor on the plasma volume but on their entrance velocity and on the plasma parameters. The authors thank S. A. Bystrov for assisting with the experiment. Figures 2, references 12: 9 Russian, 3 Western.  
[172-2415]

DYNAMICS AND RADIATION OF OPEN (VACUUM) PLASMA-DYNAMIC DISCHARGES OF  
PLASMA FOCUS TYPE

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 20, No 2, Mar-Apr 82  
(manuscript received 25 Feb 80) pp 359-375

KAMRUKOV, A. S., KOZLOV, N. P. and PROTASOV, Yu. S., Moscow Higher Technical  
School imeni N. E. Bauman

[Abstract] An extensive experimental study was made to determine the space-time structure and the spectrum of radiation from open high-current plasma-dynamic discharges of the plasma focus type under deep vacuum down to  $10^{-3}$  Pa, such discharges being produced in magnetoplasma compressors. Discharges of this kind were produced in vapors of four metals (Cu, Cd, Al, Mo) with  $C_2F_4$  plasma, these metals being used correspondingly for electrodes with thermally stable dielectric (boron carbonitride BNC, zirconium dioxide  $ZrO_2$ , or alundum  $Al_2O_3$ ) spacers. These discharges were produced from a bank of IMM-5-150 low-inductance capacitors. The discharge dynamics and the radiation spectrum were measured covering the range of wavelength from visible to far ultraviolet and the 2-350 eV range of quantum energy. Coefficients of bremsstrahlung and photoionizing absorption were calculated according to the approximate quantum-defect theory. The results suggest several possibilities of controlling the emission spectrum, namely by varying the structure or the chemical composition of the hypersonic stream in the interelectrode space of the MHD compressor. High utilization of the active substance and adequate MHD compression, with necessary high electromagnetic energy density, will ensure attainment of high plasma temperatures and thus also high brightness temperatures in the focus region. The authors thank P. A. Ovchinnikov and A. G. Opekan for assistance in the study. Figures 11, references 56: 50 Russian, 6 Western.

[180-2415]

AXIAL COMPRESSION AND SOME ULTIMATE CHARACTERISTICS OF HIGH-VOLTAGE  
GLOW DISCHARGE

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 20, No 2, Mar-Apr 82  
(manuscript received 22 Dec 80) pp 207-214

PUSTYNSKIY, L. N., KHOLEV, S. R. and YAKUSHIN, G. V., Moscow

[Abstract] An extensive experimental study was made of 100-200kV glow discharge axially compressed in cylindrical chambers. Two glass cylinders were

used, both having 10-15 mm thick walls, one 200 mm high with a 90 mm bore and one 300 mm high with a 300 mm bore. Both electrodes were made of stainless steel, the cathode surface specially hardened and smoothed by cold working with a steel ball. Radial current distributions at the anode and the cathode were measured under pressures from 1.8 to 4 Pa. The pressure dependence of maximum voltage and current prior to stability loss was also measured. These characteristics as well as transition from spark to arc discharge were found to depend on gas-tightness, tube surface finish in the cathode region, clearance between cathode and tube wall and charge density gradient in the region of cathode potential drop. The authors thank V. P. Sadov and V. P. Romantsov for active participation in the initial stage of this study. Figures 7, references 11: 6 Russian, 5 Western.

[180-2415]

UDC 537.525

DOMAIN INSTABILITY OF NONSELF-MAINTAINED DISCHARGE IN ELECTRONEGATIVE GASES,  
PART 1: THEORETICAL ANALYSIS

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 20, No 2, Mar-Apr 82  
(manuscript received 12 Dec 80) pp 201-206

BARKALOV, A. D. and GLADUSH, G. G., Institute of Atomic Energy imeni  
I. V. Kurchatov

[Abstract] The nonlinear stage of adhesive instability of nonself-maintained discharge is analyzed theoretically, on the basis of the domain formation and annihilation mechanism. Moving domains, with a velocity higher than the ion drift velocity, and static domains are considered in the analysis. The differential equations for electric field intensity and positive-ion concentration, with the corresponding dimensionless characteristic equations, are solved in the phase plane, where a closed integral curve describes periodic solutions and where singular points of various kinds depending on the domain velocity can be found. An expression is derived for the domain velocity and estimates are obtained for the thicknesses of leading and trailing domain edges.

Figures 3, references 5 Russian.

[180-2415]

## SUPERCONDUCTIVITY

UDC 539.292

### SUPERCONDUCTIVITY OF METALLIC GALLIUM PHOSPHIDE

Kiev FIZIKA NIZKIKH TEMPERATUR in Russian Vol 7, No 11, Nov 81  
(manuscript received 30 Jun 81) pp 1479-1481

TIMOFEYEV, Yu. A., VINOGRADOV, B. V. and YAKOVLEV, Ye. N., Institute of High-Pressure Physics, USSR Academy of Sciences, Troitsk (Moscow oblast)

[Abstract] An experimental study of metallic gallium phosphide has revealed a superconducting transition at the temperature  $T_c = 9.3$  K. Measurements were made in a high-pressure chamber of the "rounded cone - plane" configuration, with a thin layer of GaP powder deposited on the plane anvil of VK-6 hard alloy, transition of gallium phosphide from dielectric to metallic state occurring under a mean pressure of 22 GPa. In a low-frequency (20 Hz) magnetic field with an induction of  $10^{-2}$  T amplitude shifted the superconducting transition to lower temperatures twice during one cycle of field alternation, while the resistance of the material varied in phase with the magnetic induction. The authors thank Dr J. Witting for providing research results prior to publication. Figures 2, references 10: 2 Russian, 8 Western.  
[167-2415]

THEORETICAL PHYSICS

UDC 517.946:519.46

EXACT QUASI-PERIODIC AND SOLITON SOLUTIONS TO NONLINEAR EQUATIONS OF WAVE PULSE PROPAGATION THROUGH DISSIPATIONLESS TWO-LEVEL MEDIUM

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR, SERIYA A: FIZIKO-MATEMATICHESKIYE I TEKHNICHESKIYE NAUKI in Russian No 4, Apr 82 (manuscript received 5 Feb 81) pp 5-9

BOGOLYUBOV, N. N., Jr, PRIKARPATSKIY, A. K. and SAMOYLENKO, V. G., Mathematical Institute imeni V. A. Steklov; Institute of Mathematics, both of UkrSSR Academy of Sciences

[Abstract] The periodic problem for the differential equations of wave pulse propagation through a dissipationless two-level medium

$$\frac{\partial E}{\partial t} + \frac{\partial E}{\partial x} = -2ip \frac{\partial n}{\partial t} = i(E_p^* - E_p) \quad \frac{\partial p}{\partial t} = -2inE$$

(E-complex wave amplitude,  $p$ ,  $n$ - elements of density matrix  $\hat{p} = \begin{pmatrix} n & p \\ p^* & -n \end{pmatrix}$ ) is

solved by methods available for the nonlinear Korteweg-de Vries equation and those available for the nonlinear Schrödinger and Riccati equations. Two linear operators  $X_\lambda$  and  $T_\lambda$  are defined in the space of complex differentiable vector functions

$$X_\lambda = \frac{\partial}{\partial x} + i\lambda \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} + i \begin{pmatrix} 0 & E \\ E^* & 0 \end{pmatrix} + \frac{i}{\lambda} \begin{pmatrix} n & p \\ p^* & -n \end{pmatrix} \quad T_\lambda = \frac{\partial}{\partial t} - i\lambda \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} - i \begin{pmatrix} 0 & E \\ E^* & 0 \end{pmatrix}$$

( $\lambda$ - arbitrary complex parameter). Both the density matrix and the complex wave amplitude are assumed to be periodic functions of the space coordinate  $x$ . The monodromy matrix  $s(x, t, \lambda)$  for the  $X$ -operator is introduced that satisfies the equations

$$\frac{\partial S}{\partial x} = [S, Q] \quad \frac{\partial S}{\partial t} = [S, \Lambda]$$

(matrices  $Q$  and  $\Lambda$  equal to the nondifferential parts of operators  $X_\lambda$  and  $T_\lambda$  respectively) and yields two equivalent systems of wave pulse equations. A theorem is stated stipulating under what conditions these systems of equations admit polynomial (in  $\lambda$ ) solutions. Solutions to the original equations are

examined subsequently and another theorem is stated stipulating under what conditions it has exact quasi-periodic solutions reducible to quadratures. Article presented by Academician Yu. A. Mitropol'skiy, UkrSSR Academy of Sciences. References 10: 7 Russian, 3 Western.  
[176-2415]

UDC 531.34

METHOD OF MOMENTS IN PROBLEMS OF DYNAMICS FOR SYSTEMS WITH RANDOMLY VARYING PARAMETERS

Moscow PRIKIADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 46, No 2, Mar-Apr 82  
(manuscript received 14 May 81) pp 218-224

DIMENTBERG, M. F., Moscow

[Abstract] Equations of the moment method are derived for linear dynamic systems with randomly varying parameters, assuming that parametric random perturbations in such a system are normal processes of the "white noise" kind uncorrelated to similar external random actions. On this basis a system is analyzed with one degree of freedom

$$\ddot{x} + 2\alpha \dot{x} + \Omega^2 x [1 + \xi(t)] = y(t) = \zeta(t)$$

where  $\xi(t)$ ,  $\zeta(t)$  are wideband stationary random processes and  $\alpha$ ,  $\Omega$  are constant parameters. In the case of small spectral densities of both random processes as well as a small parameter  $\alpha$  it is permissible to change variables, namely  $x = A(t)\cos\theta(t)$ ,  $\dot{x} = -\Omega A(t)\sin\theta(t)$ ,  $\theta = \Omega t + \phi(t)$ . A subsequent analysis of the dynamics by the moment method is found to be more extensive than analysis by the perturbation method. The moment method is then applied to a system with two degrees of freedom

$$\ddot{x}_1 + 2\alpha_1 \dot{x}_1 + \Omega_1^2 x_1 = \lambda_{12} x_2 \xi(t) + \zeta_1(t)$$

$$\ddot{x}_2 + 2\alpha_2 \dot{x}_2 + \Omega_2^2 x_2 = \lambda_{21} x_1 \xi(t) + \zeta_2(t)$$

where  $\xi(t)$ ,  $\zeta_i(t)$  are centered wideband stationary random processes. The method is also extendable to systems with correlated internal and external random perturbations. The author thanks V. B. Kolmanovskiy for discussing this study. References 10: 9 Russian, 1 Western.

[179-2415]

MATHEMATICS

UDC 512.624

NUMBER OF CLASSES OF PROJECTIVELY EQUIVALENT BINARY FORMS OVER FINITE FIELD

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR, SERIYA A: FIZIKO-MATEMATICHESKIYE I TEKHNICHESKIYE NAUKI in Russian No 4, Apr 82 (manuscript received 16 Jul 81) pp 9-12

VISHNEVETSKIY, A. L., Khar'kov Military Air Force College of Communications

[Abstract] A second-degree projective group  $G = PGL(2, q)$  is given over a finite field  $F$  of  $q$  elements. Its elements are  $2 \times 2$  matrices over  $F$ , treated with an accuracy down to an arbitrary multiplier among  $F \setminus \{0\}$  and  $F_n$ .  $[x, y]$  is a set of  $n$ th-degree binary forms over  $F$  treated with an accuracy down to some multiplier among  $F \setminus \{0\}$ . Nine theorems are stated pertaining to numbers of  $H$ -,  $G$ -,  $H_0$ - orbits of the  $F_n$   $[x, y]$  set, number of  $H_0$ -orbits of the  $F_n[x]$  set, number of  $H_0$ -orbits of the set of  $n$ th-degree polynomials irreducible over  $F$ , numbers of  $H_0$ -,  $G$ - orbits of the  $F_n'$   $[x]$  set of  $n$ th-degree polynomials over  $F$  without roots in  $F$ , number of  $G$ - orbits of the  $F_n'$   $[x, y]$  set, number of  $G$ - orbits of the set of  $n$ th-degree forms irreducible over  $F$ , and number of  $n$ th-degree nonisoclinic  $P$  groups. Another theorem is stated pertaining to numbers of nonequivalent Goppa codes. Article presented by Academician Yu. A. Mitropol'skiy, UkrSSR Academy of Sciences. References 7: 4 Russian, 3 Western. [176-2415]

UDC 518.90

NORMAL FORM OF POSITIONAL GAMES

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 264, No 1, May 82 (manuscript received 13 Nov 81) pp 30-33

GURVICH, V. A., Institute of Terrestrial Physics imeni O. Yu. Schmidt, USSR Academy of Sciences

[Abstract] The simplest model of a positional game, namely a tree with branches and vertices including the top, is considered for the purpose of constructing

the matrix of its normal form. The theorem that such a matrix must be stable and rectangular is subsequently applied to two-color graphs and nonrepeatable Boolean functions with corresponding strategies. Article presented by Academician L. V. Kantorovich 13 October 1981. Figures 3, references: 4 Russian.  
[170-2415]

UDC 517.946+532.135

ANALYSIS OF SOLUTIONS TO DIFFERENTIAL EQUATION NOT RESOLVABLE WITH  
RESPECT TO DERIVATIVE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 264, No 1, May 82  
(manuscript received 4 Nov 81) pp 11-13

AKHMEROV, R. R. and NOVIKOV, V. A.

[Abstract] The second-order ordinary differential equation not resolvable with respect to the derivative  $\frac{d}{dx} \left[ v \cdot \left( \frac{du}{dx} \right) \frac{du}{dx} \right] = u \frac{du}{dx}, x \in [0, X], u(0)=a, u(X)=b$

is the steady-state version of the N. N. Yanenko equation describing intricate flow of viscous fluids,  $u: [0, X] \rightarrow \mathbb{R}$  being an unknown function and  $v: \mathbb{R} \rightarrow \mathbb{R}$  being a fixed alternating asymptotically positive smooth function having the form of a second-degree polynomial with positive coefficients. This equation is solved for a set of two boundary conditions, at  $x = 0$  and at  $x = X$ , through integration and subsequent reduction to the corresponding first-order Cauchy problem also not resolvable with respect to the derivative. Four classes of solutions are defined on the basis of continuity and differentiability of the function  $u: [0, X]$ . Solutions to the original differential equations are then extended to include an  $n$ -th class and symmetrized fourth-class ones. Six theorems are stated pertaining to the existence and the number of solutions in each class. Article presented by Academician N. N. Yanenko 27 October 1981. References 3 Russian.

[170-2415]

UDC 62-50

OBSERVATION OF LINEAR OBJECT

Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 46, No 2, Mar-Apr 82  
(manuscript received 24 Jan 81) pp 212-217

PSHENICHNYY, B. N. and POKOTILO, V. G., Kiev

[Abstract] The problem of observing an object on the basis of signals  $y_t = \phi_t z + w_t$  ( $t \in T$ ,  $z \in R^n$ ,  $z$ - unknown vector of parameters,  $\phi_t$ -determinate  $m \times n$  matrices,  $w_t$ -stationary in-narrow-sense random process) is considered when random perturbations occur in the measuring channel. A few constraints on the system and on the  $w_t$ -process are stipulated, this process assumed to be a regular one with weak mixing. Two theorems are stated and proved pertaining to estimates  $z_1(\psi, N)$  of the scalar quantity  $\psi z$  ( $\psi \in R^n$ ,  $\|\psi\| = 1$ ,  $N$ - number of readings). The consequences of these theorems are applied to a linear dynamic system  $\frac{dx}{dt} = Ax$  ( $t \geq 0$ ) and vectors  $y_k = Bn(t_k) + w_k$  read at discrete intervals of time. An additional lemma is proved and illustrated on two examples with

$$\text{matrices } A \text{ and } B: A = \begin{vmatrix} 0 & 1 \\ 0 & 0 \end{vmatrix}, B = \|1, 0\|; A = \begin{vmatrix} 0 & 0 \\ -\omega^2 & -2\delta \end{vmatrix}, B = \|1, 0\|.$$

References 4 Russian.

[179-2415]

UDC 62-50

PROPERTIES OF POTENTIAL IN DIFFERENTIAL GAME

Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 46, No 2, Mar-Apr 82  
(manuscript received 16 Jun 81) pp 204-211

SUBBOTIN, A. I. and SUBBOTINA, N. N., Sverdlovsk

[Abstract] A positional differential two-player game with fixed termination time is considered, of particular interest being necessary and sufficient conditions which the potential (value function) in such a game must satisfy to ensure stability. Three theorems are stated and proved, with the aid of three lemmas, pertaining to these conditions. The first applies to a continuous potential, the other two apply to the class Lip (Lipschitz condition) of value functions differentiable with respect to directions. Such functions include piecewise-smooth ones and functions regular up to some boundary. A fourth theorem, a corollary of the third, extends the latter for  $Lip \cap Dif$  value functions to the problem of optimal programmable control (minimization of a functional). References 15: 11 Russian, 4 Western.  
[179-2415]

OPTIMALITY PRINCIPLES IN COOPERATIVE DIFFERENTIAL GAMES WITH NONTRANSFERRABLE PAYOFFS

Budapest PROBLEMY UPRAVLENIYA I TEORII INFORMATSII in Russian Vol 11, No 1, Jan-Feb 82 (manuscript received 10 May 81) pp 29-39

DANILOV, N. N., Kemerovo State University

[Abstract] The author considers cooperative differential games with non-transferrable payoffs as a characteristic set with optimality defined in the sense of stability. This idea was first considered by L. A. Petrosyan [see "Stability of Solutions in Differential Games With Many Participants", VESTNIK LENINGRADSKOGO UNIVERSITETA, No 19, 1977]. Here Petrosyan's approach is extended to a wider class of games, and conditions of existence of some stable solutions of such games are established. Using the properties of the proposed characteristic set, an alternative theorem is proved with reference to the initial capabilities of the players, asserting that either only one player can achieve positive results by forced actions, or a coalition can prevent any player from favorable action. The problem of stability of solutions is studied in a nonantagonistic differential game treated as a cooperative game with nontransferrable payoffs. Stability conditions are found for  $M_i^{(i)}$ -stable configurations, and a constructive method is given for producing such a set. References 4 Russian.

[175-6610]

CONFERENCE ON PARTIAL DIFFERENTIAL EQUATIONS

Moscow USPEKHI MATEMATICHESKIKH NAUK in Russian Vol 37, No 2(224), Mar-Apr 82 pp 263-268

SKRYPNIK, I. V., DANILYUK, I. I., MARKOVSKIY, A. I. and MEL'NIK, Z. O.

[Abstract] The second conference on partial differential equations was held by the Institute of Applied Mathematics and Mechanics (UkSSR Academy of Sciences) on 18-20 September 1981 at the "Latoritsa" sports and health resort, in memory of Yaroslav Borisovich Lopatinskiy (deceased on 10 March 1981). Participating in the conference were 159 mathematicians from 29 Soviet cities, among them 32 with degrees of doctor and 67 with degrees of candidate. Part of the conference was devoted to Lopatinskiy's work and contributions in the field of boundary-value problems. Other topics included behavior of solutions to systems of equations of theory of elasticity at infinity, global solvability of Cauchy problem, attractors of nonlinear parabolic equations, Lie algebras and superalgebras. Brief presentations were made on self-coupling of

differential operators and evolutionary equations, perturbations of nonlinear Fredholm operators, bifurcation of waves describable by parabolic equations, nonlinear differential equations of integral geometry, linear elliptic equations with degeneration into general boundary-value problems, trigonometric series in mathematical physics, quasi-stationary Stefan problem, wave equation in Riemann space, Green matrix of parabolic boundary-value problems with increasing coefficients, continuity of solutions to elliptic equations, generalized solutions to Cauchy problem for Burgers and Korteweg-de Vries equations, behavior of solutions to quasilinear elliptic equations in unbounded regions, nonstandard analysis, approximation of solenoidal and potential vector fields, linear degenerating parabolic boundary-value problems, Fragman-Lindelof principle, coupling of solutions to second-order partial differential equations in a plane,  $(s, \beta)$ -volume and its use for solving second-order elliptic equations, special boundary-value problems, solvability of general elliptic boundary-value problems with a parameter in  $L_p$ -spaces of generalized functions, theory of branching continuous fractions and its use for solving differential equations, nonlinear elliptic boundary-value problems in regions with fine-grain boundary, new method of analyzing degenerate hyperbolic equations, nonlinear boundary-value problems for minimum-surface equations, backscattering problem for electric signals, spectral problem for Laplace operator in fundamental regions of finite groups of reflections by special Riemann manifolds, mathematical theory of stochastic automata and use of partial differential equations, and mixed problem for equations well-conditioned according to I. G. Petrovskiy. The transactions will be published. The next conference will take place in 1983 in Donetsk.

[177-2415]

#### COHOMOLOGS OF CERTAIN LIE ALGEBRAS AND SUPERALGEBRAS OF VECTOR FIELDS

Moscow USPEKHI MATEMATICHESKIKH NAUK in Russian Vol 37, No 2(224), Mar-Apr 82  
(manuscript received 7 May 81) pp 233-234

RETAKH, V. S., Central Scientific Research and Experimental Design Institute of Industrial Buildings and Structures, and FEYGIN, B. L., Institute of Solid-State Physics

[Abstract] A new method is proposed for calculating the cohomologs of null-potent subalgebras of Lie superalgebras of vector fields in an  $(n,k)$ -dimensional space. The method is based on five theorems pertaining to one family  $L_1(t)$  of Lie algebras and two families  $N_1(t)$ ,  $N_2(t)$  of Lie superalgebras. These theorems establish the properties of cohomologs, namely the manner of their generation and continuation, as well as the conditions of triviality of spaces of generating algebras and the relation between them. The authors thank D. A. Deytes and D. B. Fuks for assistance. References 4: 3 Russian, 1 Western.  
[177-2415]

BOUNDED AND QUASI-PERIODIC SOLUTIONS TO CERTAIN NONLINEAR EVOLUTIONARY EQUATIONS

Moscow USPEKHI MATEMATICHESKIKH NAUK in Russian Vol 37, No 2(224), Mar-Apr 82  
(manuscript received 13 May 81) pp 223-224

PANKOV, A. A., Institute of Application Problems in Mechanics and Mathematics

[Abstract] A theorem is proved establishing the existence of solutions to the equation  $\frac{du}{dt} + L(t)u + A(t,u) = f(t)$ , also the conditions under which such a solution will be unique and independent of time t. Quasi-periodicity of this equation according to Bezikovich and its solvability in Stepanov spaces are also dealt with. The results can be applied to other equations such as a symmetric hyperbolic one and a nonlinear one of the Schroedinger kind.

References 4 Russian.

[177-2415]

ASYMPTOTIC EXPRESSIONS FOR SOLUTION OF SYSTEM OF NONLINEAR SCHROEDINGER EQUATIONS

Moscow USPEKHI MATEMATICHESKIKH NAUK in Russian Vol 37, No 2(224), Mar-Apr 82  
(manuscript received 10 Aug 81) pp 215-216

NOVOKSHENOV, V. Yu., Department of Physics and Mathematics, Bashkir branch, USSR Academy of Sciences

[Abstract] The "vector" nonlinear Schrödinger equation

$$i\frac{\partial u_n}{\partial t} + \frac{1}{2}\frac{\partial^2 u_n}{\partial x^2} + u_n \sum_{k=1}^N |u_k|^2 = 0 \quad (n=1,2,\dots,N)$$
 with the initial condition

$u_n(x,0) = u_n^0(x)$   $u_n^0 \in L_1$  is considered, this equation appearing in the theory of two-dimensional self-focusing of electromagnetic waves with polarization. The soliton-free asymptotic behavior at  $t \rightarrow \infty$  of the solution to the corresponding Cauchy problem in class  $L_1$  is established on the basis of a theorem involving certain properties of the scattering matrix. The problem of determining the asymptotic behavior here is more difficult than for the scalar nonlinear Schrödinger equation, inasmuch as solution of the scattering equations must be extended from  $-\infty$  to any  $\lambda$  in the upper half-space. References 5 Russian.

[177-2415]

LOWER LIMIT OF MEAN VOLUME OF SEQUENTIALLY CONTROLLABLE SAMPLE

Moscow USPEKHI MATEMATICHESKIKH NAUK in Russian Vol 37, No 2(224), Mar-Apr 82  
(manuscript received 14 Oct 81) pp 209-210

MALYUTOV, M. B., Moscow State University

[Abstract] For sequential design of experiments the identity and the lower limit according to A. Wald are extended to an arbitrary sequential plan. With the aid of three lemmas, a theorem is proved pertaining to deficiency of a weaker estimate. Another theorem is proved pertaining to class A of strategies with all probabilities given, whereupon the estimate in this case is compared with the Hefding estimate. References 4: 3 Russian, 1 Western.  
[177-2415]

COHOMOLOGS OF  $gl(n)$  ALGEBRA IN CASE OF FINITE CHARACTERISTIC

Moscow USPEKHI MATEMATICHESKIKH NAUK in Russian Vol 37, No 2(224), Mar-Apr 82  
(manuscript received 1 Sep 81) pp 199-200

KOZERENKO, K. V., Institute of Control Problems, USSR Academy of Sciences

[Abstract] Cohomologs of the complete  $gl(n)$  matrix algebra with trivial coefficients are established for the case of a finite-characteristic rather than zero-characteristic field. New tensor invariants appear when the tensor rank is equal to the product of field characteristic by the matrix order. Cohomologs of this algebra are shown to differ from the classical ones already when  $n-1$  is equal to the field characteristic. This is demonstrated by multigraduation in  $C^*(gl(n,F))$  for the two cases  $(r_1, \dots, r_n) \neq (0, \dots, 0)$  and  $(r_1, \dots, r_n) = (0, \dots, 0)$ . An appropriate theorem is stated and proved for each case. The author thanks D. B. Fuks for formulating the problem and guidance, also B. L. Feygin for helpful suggestions. References 4 Russian.  
[177-2415]

UDC 517.98

FOURIER SERIES OF PERIODIC ULTRADISTRIBUTIONS

Kiev UKRAINSKIY MATEMATICHESKIY ZHURNAL in Russian Vol 34, No 2, Mar-Apr 82  
(manuscript received 22 Jun 80) pp 144-150

GORBACHUK, V. I., Institute of Mathematics, UkrSSR Academy of Sciences

[Abstract] Generalized periodic functions of the ultradistribution type of class  $D'_{\{m_k\}}$  or  $D'(m_k)$  are represented by Fourier series, and such series are summed by the Abel-Poisson method. It is shown that all classes of generalized periodic functions are embedded in the space of formal trigonometric series, and are completely described by the behavior of the coefficients or partial sums of their Fourier series. The author also establishes localization of abelian transformation of ultradistributions of the given classes. References 4 Russian.

[161-6610]

UDC 519.21

SUPERPOSITION OF TWO DEPENDENT MARKOVIAN RECONSTRUCTION PROCESSES

Kiev UKRAINSKIY MATEMATICHESKIY ZHURNAL in Russian Vol 34, No 2, Mar-Apr 82  
(manuscript received 17 Sep 80) pp 171-176

KONOVALYUK, V. S., Kiev State University

[Abstract] The author generalizes the results of a previous article [Konovalyuk, V. S., "Two-Channel System With Dependent Failures", KIBERNETIKA, No 6, 1981, pp 81-87], where the steady-state distribution of two dependent reconstruction processes was found. The same method of proof of the theorem is used. In this paper, steady-state distribution of the superposition of two dependent markovian reconstruction processes is found, where superposition is understood to mean the process in which transition from state to state takes place at the instants of change in the states of the superposed processes, and dependence means that there is a certain probability of a change in state of one of the processes at the instant of transition from state to state of the other process. References 3 Russian.

[161-6610]

UDC 621.3.078

SYNTHEZIZING REFERENCE MODE FOR CONTROL SYSTEMS UNDER CONDITIONS OF UNCERTAINTY

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian  
Vol 25, No 3, Mar 82 (manuscript received 21 Apr 81) pp 25-28

KOVAL'SKIY, V. S., Moscow Higher Technical Academy imeni N. E. Bauman

[Abstract] In solving some control problems it is important to account for different kinds of uncertainties because of the absence of reliable information on perturbations and their statistical characteristics and because of stringent requirements on reliability of attainment of the terminal state. Under these conditions, definition of a reference mode is an important stage in synthesizing control systems. In this paper the author suggests a possible approach to solution of the problem of transferring the state of an object described by a system of ordinary differential equations into a predetermined region of states under conditions of uncertainty. The optimum reference mode is determined that minimizes the risk of attaining the goal. The suggested approach reduces calculation of the reference mode to solution of a Cauchy problem. The idea behind calculation of the reference mode is that the given terminal state is transported in reverse time in such a way that when motion is in forward time the control system has maximum guaranteed reserves of control at every instant. Figure 1, reference 1 Russian.

[164-6610]

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